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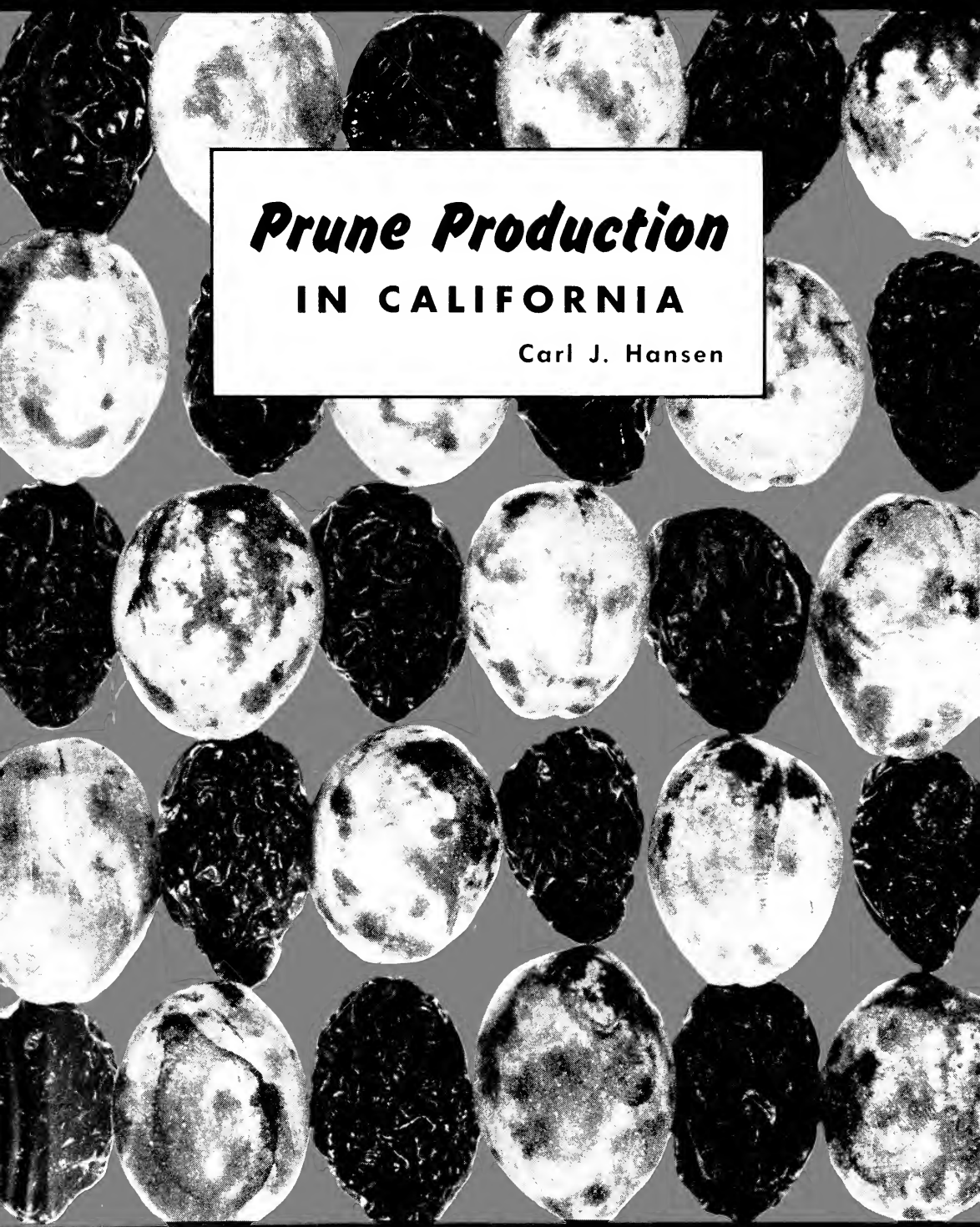

Prune Production IN CALIFORNIA

Carl J. Hansen

CALIFORNIA AGRICULTURAL EXTENSION SERVICE

CIRCULAR 180

Prune Production

is of major importance in several counties of California where the climatic and other conditions are favorable.

This Circular

points out the factors that make for commercial success, and in many cases, gives recommended procedures for obtaining profitable yields of quality fruit.

Briefly—success depends on selecting a favorable site for the raising of prunes; selecting desirable varieties and rootstocks; giving the young trees adequate care and training; applying cultural practices that are known to produce good results.

This circular does NOT discuss the cultural practices that apply to plums destined for fresh shipment—it is concerned only with prunes—plums that are destined for drying. Nor does this circular discuss processing techniques; those will be found in other publications issued by the College of Agriculture.

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Section I. Planning and establishing the orchard

The prospective grower is advised to consider a number of things that will influence success or failure

A prune is usually defined as a plum that can be satisfactorily dried whole without fermentation at the pit. Of the numerous species of plums grown in the United States, only one, the European plum (*Prunus domestica*), contains varieties which meet the requirements of this definition of a prune. Even in this species many varieties will not dry properly, and so may only be eaten fresh or, in a few cases, canned. Since a high sugar content is one of the factors necessary for proper drying, most prunes are very sweet to the taste.

This publication is confined to a discussion of the production and harvesting of prunes that are to be dried.

To be successful in a prune-raising venture, a grower must be able to produce fruit of acceptable quality, at a cost that will enable him to compete with other growers and still make a profit. While prunes will grow in many parts of California, successful *commercial* production depends on efficient operation, plus any natural advantages accruing from choice of a location for the planting.

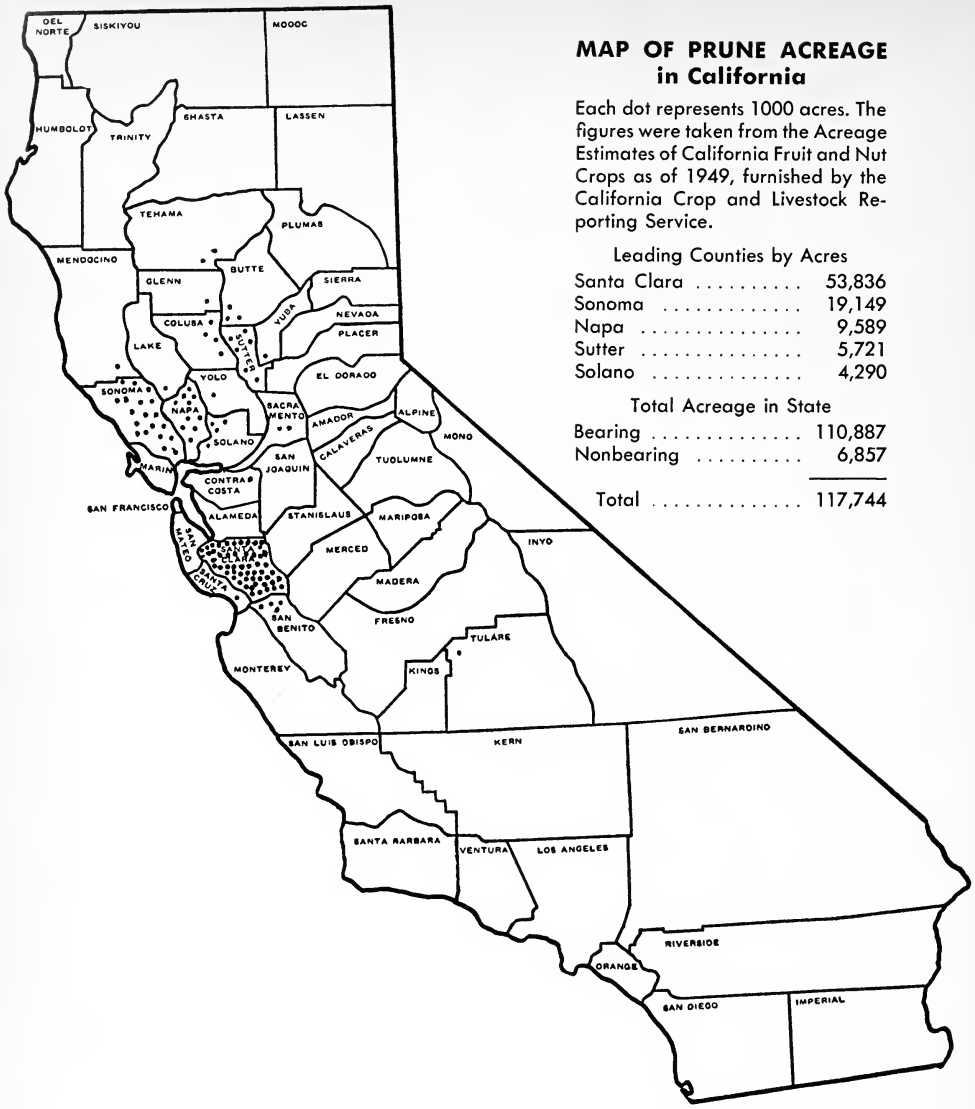
IN THIS SECTION

1. Soil and climatic needs

Soil. Prunes are grown on a wide variety of soils, although a deep, well-drained, medium-textured soil is generally the best. If prunes are planted on heavy soils that are a little too wet part of the year, it is important to use as a rootstock either myrobalan plum or one of the other types of plum. Peach should not be used as a rootstock under these conditions because it will not tolerate heavy, wet soils. Prunes can be grown on light, sandy soils but more frequent irrigation and often more frequent fertilization will be required.

Some of the very heavy soils, for example adobe, are objectionable in that prune trees growing on them are usually small in size, and it is difficult to properly prepare the smooth surface that is required for the harvesting operations.

Climate. The prune requires a moderately long season of clear, warm weather for proper maturity. These conditions are satisfied in some of the central coast valleys and in the great interior valleys. Some fog occurs in the coastal valleys where prunes are commonly grown, but it usually clears early enough in the morning so that an adequate amount of sunshine is available. Areas close to the



MAP OF PRUNE ACREAGE in California

Each dot represents 1000 acres. The figures were taken from the Acreage Estimates of California Fruit and Nut Crops as of 1949, furnished by the California Crop and Livestock Reporting Service.

Leading Counties by Acres

Santa Clara	53,836
Sonoma	19,149
Napa	9,589
Sutter	5,721
Solano	4,290

Total Acreage in State

Bearing	110,887
Nonbearing	6,857
Total	117,744

ocean, where considerable fog occurs, are not suitable for the production of prunes.

The prune blooms later than some other fruits such as the almond and apricot, so is less likely to be injured by late spring frosts. There are, however, areas where frosts occur late enough to freeze prune blossoms and young fruits. A few growers have successfully used orchard heaters in prune orchards, but generally it is best to avoid planting the trees in places where heating is necessary, because the prune is not a high enough priced commodity to warrant this additional cost.

Prune trees do, however, require a certain amount of cold weather during the winter to break the rest in the trees. If this rest is not properly broken, the trees do not blossom normally or send out the normal number of new shoots in the spring. Some of the flower buds open long before the others and some leaf buds that would normally grow stay dormant. Because of this requirement for cold during the dormant season, most prune varie-

ties do not do well in the southern part of California, where the winters are frequently warm.

Major districts. Because of the soil and climatic conditions given above, the prune industry in California tends to be concentrated in the central coast valleys, in Santa Clara, Sonoma, and Napa counties (see map). Most of the prune acreage outside this area is located in the Sacramento Valley.

In the coastal valleys, the prunes usually drop easily to the ground when they are ripe; those in the interior valley tend to hang on the trees even *after* they are ripe. This difference, apparently a result of climatic conditions, results in different methods of harvesting being employed in the different regions.

High summer temperatures, which are more common in the interior valleys than in the coastal valleys, will in some years cause the prunes' flesh to darken, and may also cause gas pockets to develop in the fruits.

Moisture requirements. An increasing number of prune orchards have been brought under irrigation during recent years. There are, however, large areas in the coastal counties north of San Francisco Bay where the rainfall and humidity are high enough to make it possible to grow prunes without irrigation.

Even in these districts, some growers have improved the health of their trees by irrigation.

The trees will be injured if the irrigation water contains excessive amounts of certain salts, including chlorides, sulfates, and boron compounds. It is important, therefore, to have an adequate supply of good water in those areas where irrigation is necessary.

2. Considerations before planting

In general, there are no special factors involved in preparing land for a prune orchard that differ from any other deciduous fruit orchard. Since most of the steps involved are fairly well standardized, and are described in detail in other publications, the following is a brief résumé of the factors to be considered, with references to specialized publications on individual operations.

Land preparation is dependent on the type of irrigation system (if any) that will be used. If irrigation is practiced, the land should be properly graded and the irrigation system installed before the trees are planted.

In grading, care must be taken to avoid scraping too deep, so that infertile subsoil is exposed. Establishing grades is a job for an engineering service, of which many are available throughout the fruit-growing sections of the state.

The irrigation system may be of the square check, contour check, or furrow methods. If the land is naturally level, or has been leveled, it will be possible to use large square checks with several trees in each check. In land with a moderate slope, it may be necessary to make square checks with only one tree in each check, but since a large amount of labor is needed to irrigate an orchard with small checks, it is suggested that the contour check method be used in those cases where large square checks cannot be used. (See Ext. Cir. 73, *The Contour Check Method of Orchard Irrigation,* by J. B. Brown.)

Contour check levees follow the natural contour of the land and the difference in elevation between the adjacent levees is usually 0.2 foot. The positions of the ridges (levees) are determined by an engineer's level.

The large checks that are possible with this system result in a saving in irrigation labor which may more than pay for the original cost of locating the levees and marking the trees for guidance.

When the furrow system of irrigation is used, care should be taken to adjust the length of the furrows and the head of water so that the water will be evenly distributed. Furrows that are too long

may result in too much water at the top end, too little at the lower end.

Laying out the orchard. Most California prune orchards are planted by the square system in which the trees and the rows are the same distance apart. Prune trees are usually planted from 22 to 25 feet apart, but in areas with deep, very fertile soil, slightly greater planting distances may be justified to allow for excess growth.

The hexagonal system, where each tree is equally distant from all surrounding trees, allows about 15 per cent more trees than the square system, in any given space. However, it is more difficult to lay out and may result in some confusion in various orchard operations.

These two systems, and others, are described in detail in *California Fruits and How to Grow Them*, by E. J. Wickson, 10th Edition, published in 1926 by the Pacific Rural Press. This book may probably be obtained now from libraries only.

Any arrangement other than the square system should probably not be used, unless special conditions justify it.

What varieties grow best? Table 1 shows at a glance the relative importance of the different varieties of prunes currently being grown commercially in California.

Table 1—California Prune Acreage by Varieties, 1949, as reported by Calif. Crop and Livestock Reporting Service.

Variety	Bearing acreage	Nonbearing acreage
Burton	410	104
French	95,710	5,976
Imperial	8,903	292
Robe de Sergeant	1,254	277
Sugar	4,228	55
Others	382	153
All prunes	110,887	6,857

It should be pointed out that the Italian prune, the leading variety in Oregon and Washington, is not grown in California. The following is a description of those varieties which are commercially important in the state.

French (Prune d'Agen, Petite Prune d'Agen). The first French prune trees in California were grown near San Jose, from grafts obtained in France in December, 1856.

The fruit is medium-sized, oval, somewhat necked, and has a small, smooth pit. The skin is purplish and the flesh is golden yellow. The only defect of importance is that the fruit is smaller than desirable during years of heavy crops.

The tree is strong and vigorous, and usually produces regular crops.

Imperial (Imperial Epineuse). This variety also originated in France, about 1870.

The fruit is large, which is an advantage, since a premium is usually paid for the larger sizes. It is oval in shape and has a purplish-red skin. The yellow flesh has a greenish tinge, although this is not as pronounced as in the Robe de Sergeant.

The chief disadvantage of this variety is that the fruit requires special attention in the dehydrater or drying yard, so there has been no tendency for the Imperial to dispute the leading place of the French prune in commercial orchards.

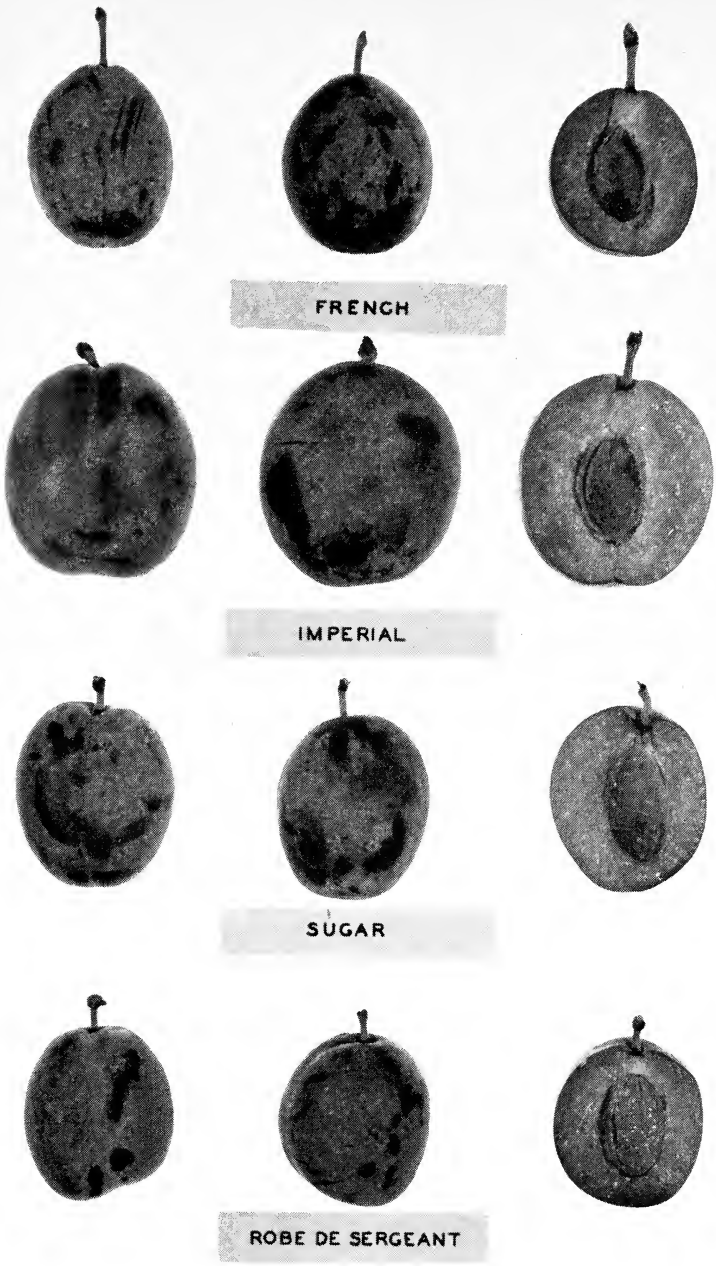
The tree is self-sterile and should be interplanted with either the French or Sugar varieties.

Sugar. This variety was introduced by Luther Burbank in 1899. In addition to being dried, this variety is also shipped as a fresh plum.

The fruit ripens earlier and is usually larger than the French prune. The skin is purplish-red and the flesh golden yellow. The pit is rather large.

The trees tend to bear a very heavy crop one year, and a very light one the next. The wood tends to be brittle and often breaks in spite of propping.

In addition to the defects in the trees, listed above, the fruit of the Sugar variety



These are representative fruits of the four leading prune varieties grown in California. French is by far the most popular variety in this state.

tends to dry into a somewhat coarse, stringy product.

Robe de Sergeant. The fruit of this variety has a purplish skin, a greenish-yellow flesh, and is approximately the same size as the French prune. The foliage of the Robe de Sergeant is glossier in appearance than that of the other common prune varieties. This variety is no better than the French and has the definite disadvantage of being self-sterile; so there seems to be no good reason to plant it generally.

Burton. This variety has never been planted extensively and the acreage is decreasing.

The fruit is large, but tender skinned, making it difficult to handle. The trees are self-sterile.

Coates 1418 (Cox, Double X, Saratoga). This variety closely resembles the French prune, but has a larger, rougher pit. The fruits are usually larger than those of the French variety during years when the crop is light or medium.

Choosing rootstocks with certain characteristics may save considerable trouble in areas characterized by certain soil conditions.

Myrobalan plum, *Prunus cerasifera*, is the most commonly used, and under most conditions probably the best rootstock for prunes. Myrobalan or one of the other types of plum rootstock should always be used in soil that is heavy and tends to be wet during part of the year. The Robe de Sergeant prune, however, is usually not satisfactory on the seedling myrobalan plum rootstocks in general use.

Myrobalan 29, a selected type of myrobalan, has been used in recent years, especially for replanting in mature orchards. This rootstock grows vigorously, is resistant to root-knot nematodes, and may be propagated by hardwood cuttings. Although it is a little more resistant to oak root fungus (Armillaria root rot) than most seedling myrobalan plums, a considerable proportion of trees have died when planted in infected soils. It is a better rootstock for the Robe de Sergeant variety than the seedling myrobalan plums.

Peach is also a satisfactory rootstock for most varieties of prunes, when grown in a soil suitable for the peach. However, the use of peach root in the interior valleys should generally be avoided because it contributes in certain years to excessively heavy crops and a resultant dieback condition of the tree.

The Robe de Sergeant and Sugar prune are not usually satisfactory on peach root.

Almond has been used to a very limited extent as a rootstock for prunes. It is not a satisfactory rootstock for Robe de Sergeant and is often unsatisfactory for Imperial and Sugar. In addition, almond roots cannot tolerate the rather heavy, wet soils that are often found in prune-growing areas.

Apricot roots have been used in root-knot nematode-infested soils, but since the unions have not always been satisfactory, it seems best to use one of the root-knot nematode-resistant plum stocks instead.

Marianna 2624, a vigorous Marianna seedling selection, has recently been used as a rootstock for prunes, in an effort to reduce the injury caused by oak root fungus. This rootstock which is propagated by hardwood cuttings is the most resistant of the prune rootstocks thus far tested. Unfortunately, some Marianna 2624 roots have been killed by oak root fungus; so it will still require a number of years to determine if the rootstock has enough resistance to justify its continued use for this purpose. It is not injured by root-knot nematodes and is a satisfactory rootstock for the Robe de Sergeant prune.

Pollination may be a problem if it is planned to grow any of the self-sterile varieties—Imperial, Robe de Sergeant and Burton.

French, Sugar, and Coates 1418 varieties are self-fruitful (they will set fruit with their own pollen). Either French or Sugar may be used as pollinizers for the self-sterile varieties.

In planting an orchard where pollinizers are needed it is preferable to have approximately every fourth row a pollinizing variety. Usually the least that should be used is one row of pollinizers in 6. Many growers plant 2, 4, or 6 rows of one variety, then 2 rows of the pollinizing variety, then repeat. More pollinizers may be included, if desired.

Experiments have shown that bees are important in helping to pollinate trees in a prune orchard, especially when self-sterile varieties are included in the planting.

Propagating the trees. Most new growers will buy their original trees from a nurseryman because he has the best facilities for propagating young trees. However, for those wishing to propagate their own trees, the following brief discussion of the steps involved is given.

The prune, like most other fruit trees, does not come true from seed, so it is necessary to bud or graft the different varieties onto a rootstock that has been grown from seed, or from a cutting.

The seedlings or rooted cuttings to be used as rootstocks are usually budded in the late summer or fall of their first or second year of growth, depending on the rootstock used. The following spring, the top of the rootstock is cut back to the bud, causing the bud to grow. During the following winter, the tree may be dug up and planted in the orchard where it is to grow.

These trees which have a one-year-old top and a two- or three-year-old root are called one-year-old, or yearling trees.

A relatively small number of prune trees are June-budded. These trees, which are usually on peach root, are produced in one season by budding the seedlings in May or the first half of June of the year they are planted. The buds are then forced into growth shortly thereafter.

For a detailed description of the handling of fruit tree seeds, and the budding and grafting of fruit trees, see Ext. Cir. 96, *Propagation of Fruit Plants*, by C. J. Hansen and E. R. Eggers.

Grades of trees. Prune trees offered for sale by commercial nurserymen must be graded by diameter of trunk taken at a point 2 inches above the center of the bud union. It is also permissible to state the approximate height, and this is usually given. The grades are as follows.

Diameter in inches	Height in feet
¼ to ⅜	2 to 3
⅜ to ½	3 to 4
½ to 11/16	4 to 6
11/16 and up	6 to 8

It is required that these trees shall not be less than ¼ inch in diameter, or less than 8 inches high, except that June-budded trees may be as small as 3/16 inch in diameter. June-budded trees under ⅜ inch in diameter may be graded in the additional sizes, as follows: 3/16 to ¼ inch, ¼ to 5/16, and 5/16 to ⅜ inch.

A medium-sized tree is generally the most desirable, and the smallest-sized trees should probably not be purchased if trees that have made better growth are available.

Care of unplanted trees. When trees are received from the nursery (usually soon after the first of the year) but cannot be planted in the orchard at once, they should be removed from their original package and heeled in. This consists of digging a trench, and placing the tree roots in the trench, in a row, and covering them with moist soil. As a rule, the tops of the trees should point toward the southwest so that the trunks will not receive

too much direct sunlight and get sunburned.

Trees should be heeled into well-drained soil—excess moisture should not be allowed to collect around the roots.

3. Planting the trees

As stated above, trees will usually be received from the nurseryman early in January. They should be set out in the orchard as soon after that time as possible—preferably in January or February. Prune trees have been planted successfully as late as the first of April, but such a procedure is not recommended. Late-planted trees are often injured or even killed, because they may send out leaves which require water, before the root system becomes well enough established to absorb an adequate amount of moisture from the soil.

To plant, dig a hole large enough to hold the roots conveniently. Root pruning is done only when the roots are broken, twisted around each other, or too long. Many trees have been injured by too deep planting, so it is recommended that they be placed at the same depth at which they grew in the nursery.

The soil should be brought into close contact with the roots, either by tamping, or by settling the soil with water, as soon as the trees are planted.

Water should be applied to newly planted trees if the soil is dry at the time of planting, or if they are planted late in the spring. When the trees are planted without watering, it is well to leave the top 2 or 3 inches of soil loose to facilitate the penetration of rainwater.

After planting, the tops of the trees should be cut off to 24 to 30 inches above the ground. This will compensate for loss of roots when the trees were removed from the nursery, and will help to form the head at a convenient height.

Protect the tops with either whitewash or tree protectors—the prune is susceptible to sunburn when very young.

Tree protectors, made of paper or some other material, are satisfactory if they are placed on the trees in such a way that they will not be moved later in the season and thus expose tender bark that has previously been shaded.

A satisfactory whitewash may be made as follows: quicklime, 5 pounds; salt, ½ pound; sulfur, ¼ pound. Add the salt and sulfur while the lime is slaking. Allow the whitewash to age for several days before using it, then dilute to a buttermilk consistency so that it can be applied easily with a brush. For small plantings, commercial preparations may be secured from orchard supply houses.

4. Care of nonbearing trees

Fertilization. Newly planted trees often respond to the addition of nitrogen fertilizers.

Place ¼ pound of ammonium sulfate per tree (or the equivalent nitrogen content in some other fertilizer) in a band on the surface of the soil, about a foot from the trunk. Manure may also be used as a source of nitrogen when it can be obtained in sufficient quantities, and at a price comparable to inorganic fertilizers.

The young tree should have its branches evenly spaced around the trunk. This photo (taken from above) shows an ideal arrangement of the branches.

Pruning. During the first few years in the orchard, the pruning of trees is aimed primarily at the development of a shape that will lend itself to economical culture, and in getting strong crotches. The ideal tree will have 3 primary scaffold (main) branches emanating from the trunk; 2 secondary scaffold branches emanating from each primary scaffold. These 6 secondary scaffold branches then become the main framework on which the fruiting branches will grow.

Photos of a French variety prune tree taken after one season's growth in the orchard. The photo on the left was taken before pruning; the one on the right after pruning.

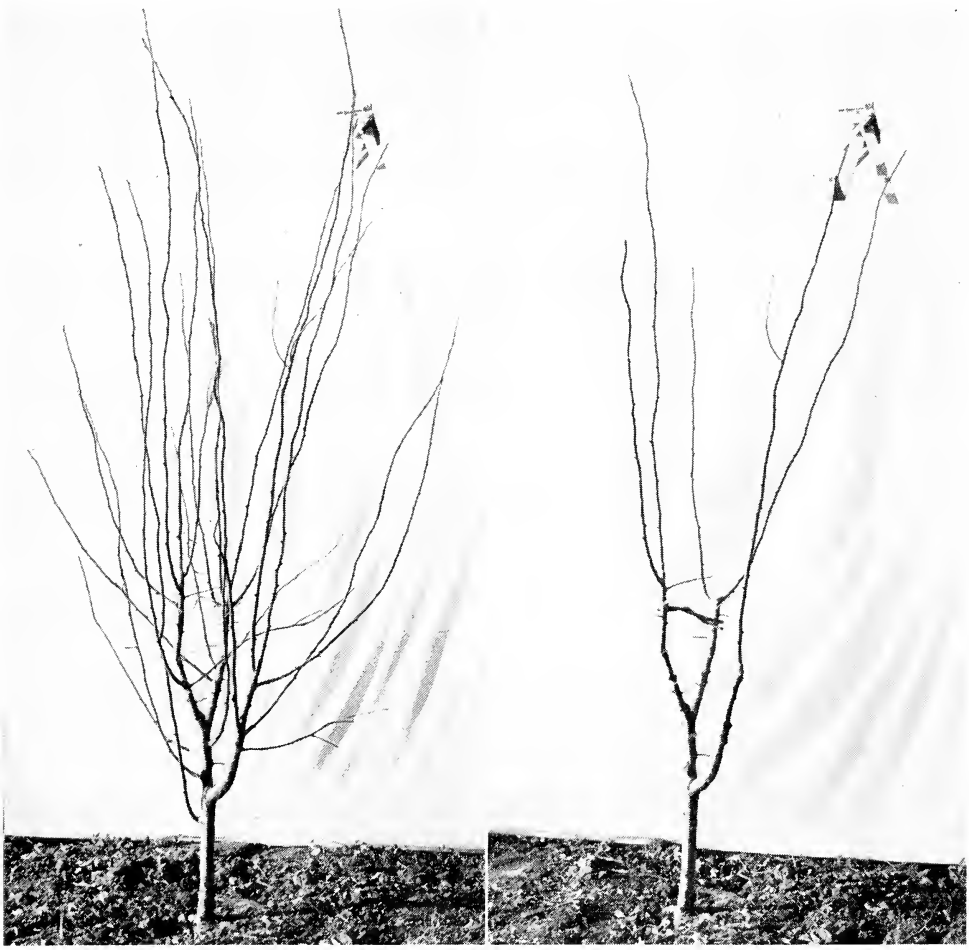
Pruning at planting. Most young prune trees as received from the nursery consist of a straight whip, without lateral branches. Thus pruning at planting usually consists merely of cutting this whip back to 24 to 30 inches from the ground.

The occasional side branches that occur on some nursery trees may be utilized in starting the main branches if they are properly located. Those branches that are saved, however, should be cut back to 6 inches or less. Unsuitable branches should be cut back to a one-half-inch stub, or a single bud.

Summer pruning should probably not be practiced where rabbits or other pests are likely to injure some of the branches.

However, if the trees are making vigorous growth, it is sometimes desirable to select the 3 primary scaffold branches during April. (The usual practice is to make this selection at the first dormant pruning. For a discussion of selection of primary scaffolds, see below.)

Summer pruning, in such cases, consists of pinching back all branches except those selected as primary scaffolds. The pinched-back branches should not be removed; some leaves should be left on them to provide shade and to manufacture food for the tree.



These photos illustrate good pruning after two seasons' growth in the orchard. Here again, a French prune tree is used as the before and after example.

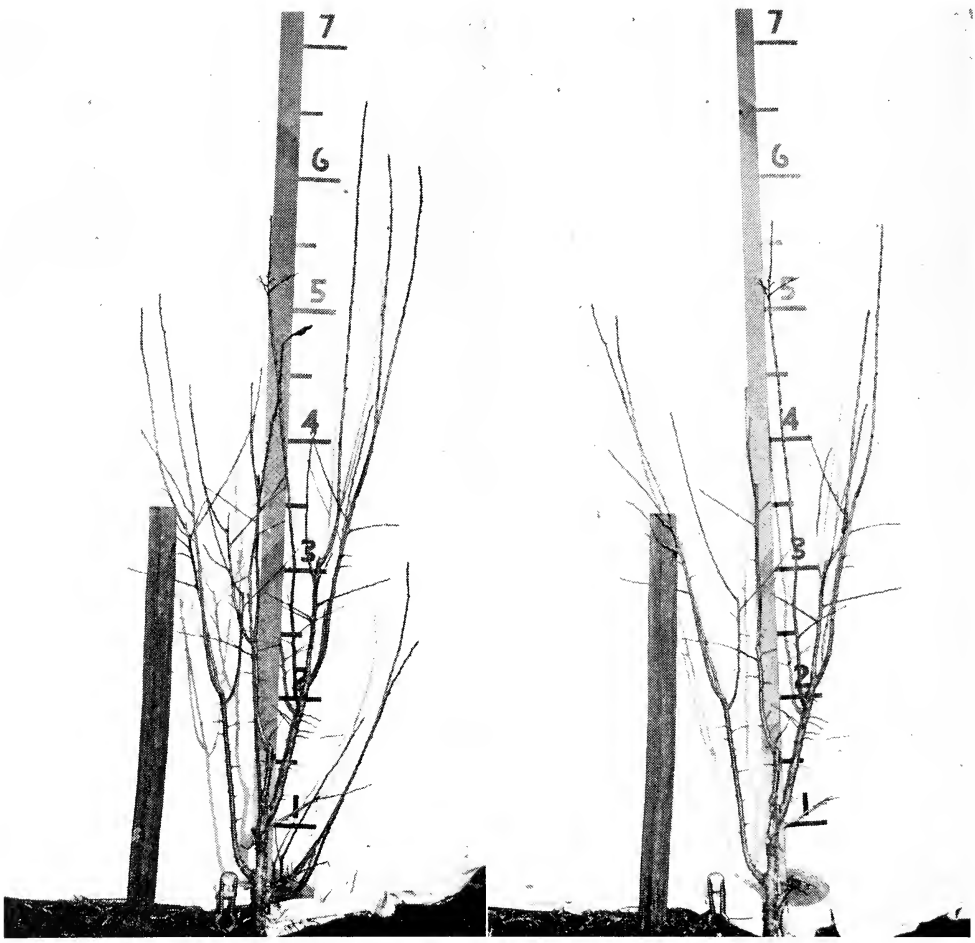
Pinching, or pruning at this time slows down the total growth of the tree, but encourages growth in those branches not cut.

The first dormant pruning should be done during the winter, after the trees have had one full season's growth in the orchard. It is during this pruning that the 3 primary scaffold branches are usually selected.

Selection of the primary scaffolds should be made on the basis of the position of the branches around the trunk, as well as up and down the trunk. In the first instance, they should form equal angles around the trunk (see photo). They should also be well distributed up and down the trunk—from 6 to 8 inches apart—so that in growing they will form strong crotches.

Unfortunately, the branches of a young tree are not always arranged in such an ideal manner, but this difficulty may be partially overcome by selecting just 2 of the primary scaffolds the first year and delaying selection of the third until the following dormant pruning.

After selection of the primary branches, the others should be removed. The primary branches should then be cut back so that they will be 15 to 30 inches long. The top branch should always be the longest. If this upper branch is not en-



Another French prune after two years growth in the orchard. In this case the center branch was pruned too heavily at the first dormant pruning, resulting in unsatisfactory growth.

couraged by being given the lightest pruning, it will often not grow as well as the others.

There is no doubt that the *best* prune trees are obtained if the primary scaffold branches are well distributed up and down the trunk. It is recognized, however, that many sturdy prune trees are bearing good crops, without breakage, even though all 3 branches arise from the trunk at about the same place.

The second dormant pruning. The amount of pruning required during the winter at the end of the second season's growth in the orchard may be reduced if unnecessary growth is removed in May. However, whether or not this summer pruning is done, the second dormant pruning will consist mainly of a thinning out of branches that are not needed. The tree shown in the photos on page 10 illustrates the type of pruning done at the end of the second season's growth in the orchard. Usually 2 secondary scaffold branches are allowed to remain on each of the 3 primary scaffold branches selected the first year. This will give 6 scaffold branches at 5 feet from the ground. More branches than this will usually result in crowding; so it is desirable to remove excess branches before they become so large that the pruning cuts will be difficult to heal.

In the case of the tree illustrated, only 5 scaffold branches were selected. Trees pruned in this way are usually as satisfactory as those with 6 scaffold branches. The branch located nearest the ground was making a little too much growth in relation to the rest of the tree, so it was pruned rather heavily to keep it from growing too fast.

As indicated above, the pruning done at the end of the second season's growth in the orchard will consist mainly of a thinning out. However, it may be necessary to head back some of the branches if they are making too much growth in relation to the rest of the tree. The tree shown in the photo on page 11 has grown 2 seasons in the orchard. It is a reasonably satisfactory tree except for one major defect that resulted from improper pruning the first year. The center branch, which is the top branch arising from the trunk, was pruned too heavily in comparison with the other branches and so is not making satisfactory growth.

Pruning in later years should be a process of thinning which consists of the removal of some branches and the cutting back of others to a side branch. If the pruning is done regularly and if proper care is given to the selection of the primary and secondary branches, it should in most cases be unnecessary to make large cuts.

Intercrops. Young prune orchards, with small trees and large distances between the trees, present the grower with a temptation to grow intercrops as a source of income before the orchard starts to bear well. This may be done, but it should be kept in mind that the development of the orchard is the primary aim and the intercrop should be handled in such a way that the growth of the trees is not materially decreased.

Reasonable space must be left between the trees and the intercrop, and adequate water and soil nutrients must be available to both at all times.

No intercrop should be grown that will introduce diseases or insects into the orchard. For example, tomatoes are not recommended as an intercrop because of the danger of introducing the fungus *Verticillium albo-atrum*, causing verticillium wilt in the tomatoes and blackheart in the prune trees.

Coöperative Extension work in Agriculture and Home Economics, College of Agriculture, University of California, and United States Department of Agriculture coöperating.
Distributed in furtherance of the Acts of Congress of May 8, and June 30, 1914.
J. Earl Coke, Director, California Agricultural Extension Service.

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CALIFORNIA AGRICULTURAL
EXTENSION SERVICE

CIRCULAR 180

Section II. Management of the bearing orchard

Satisfactory yields and quality of fruit depend on proper cultural practices in the orchard

During the first few years of growth in the orchard, the cultural practices used on prune trees are aimed at developing strong, well-shaped trees, showing vigor. The crop, if any, is unimportant.

Beginning about the fifth to eighth summer in the orchard, the trees will start to bear enough fruit so that from this time on, the crop becomes of great importance, and the value of any given tree can be measured in the amount of good fruit it will produce.

On the basis of study and experimentation over a period of many years, the following cultural practices are recommended as a means of maintaining satisfactory yield and quality in the crop.

1. Pruning

The pruning of bearing trees should be mostly a process of thinning out, which consists of the removal of unwanted branches and the cutting back of others to a side branch. If pruning is done regularly, and if proper care was given to the selection of the scaffold branches during the formative years, it should in most cases be unnecessary to make large cuts. A good distribution of healthy fruit spurs will usually result if the trees are pruned in this manner. The results have been unsatisfactory in those cases where little or no pruning has been done after the first few years. (See photos on page 2.)

However, it usually takes several years before the ill effects of improper pruning, or the lack of pruning, become evident. Eventually the spurs in the center of the tree will be killed by lack of sunlight and the bearing area will be reduced to a thin area on the outer branches of the tree. This will not only reduce the crop but will place the load near the ends of the branches and result in breakage.

Since most prunes do not have the fruit hand-thinned or picked from the tree, many prune growers have allowed the trees to grow taller than certain other kinds of fruit trees. However, pruning and spraying costs may be unnecessarily high if the trees are not kept within reasonable bounds.

Older prune trees usually produce larger and more regular crops if the trees are pruned regularly. The tree illustrated on page 2 has enough fruiting wood to produce a good crop in the interior valleys and some of the coastal areas. There are, however, some parts of the coastal counties where the percentage of flowers that develop into fruit is comparatively low, so that it is necessary to leave a little

IN THIS SECTION

A 14-year-old French prune that has been thinned moderately each year. Note open top to admit sunlight and prolong life of spurs on the main branches.

A 12-year-old French prune that has not been pruned for six years. Top is too dense to admit light and spurs in interior show a considerable loss of vigor.

A 30-year-old French prune tree that has been pruned by removing a few of the larger branches and thoroughly thinning the fruiting brush.

more fruiting wood than illustrated. In those cases where the grower does not consider it economical to prune annually from a ladder, he may find it desirable to prune from the ground in the alternate years, using a pole saw.

The Sugar prune has a strong tendency to be an alternate bearer, and the wood is more brittle than that of the other common prune varieties. In order to prevent excessive breakage, it is suggested that Sugar prune trees be pruned heavily the winter following a light crop, provided the trees have the usual heavy set of plump fruit buds. In the winter following a heavy crop, when the set of fruit buds is rather light, the pruning may be comparatively light.

This variety has a tendency to make its new growth on the tips of the previous season's shoots, so in order to prevent the formation of long, polelike branches, it is often necessary to cut back the young shoots. In those districts where growth is very vigorous and crops are heavy, a considerable amount of this type of cutting is necessary. However, in those areas where growth and fruit set are moderate, the pruning may consist mainly of a thorough thinning out. A little heavier type of pruning is usually practiced in those cases where the fruit is to be shipped fresh rather than dried, with the object of producing a high percentage of fruit of marketable size.

2. Cultivation

The usual reasons for cultivating an orchard are: to remove noxious weeds and weed competition; to facilitate subsequent orchard operations such as irrigation, harvesting, brush removal, or spraying; to incorporate covercrops and manures; to prepare a seedbed for covercrops; and to aid in the absorption of water where certain orchard operations have produced an impervious condition.

Most prune growers disk rather than plow their orchards, mainly because it is usually faster and leaves the land more nearly level. However, as far as the health of the trees is concerned, plowing is just as good as disking if the depth of cultivation is the same.

Very deep cultivation generally injures a considerable number of roots, so one should not cultivate any deeper than is necessary to accomplish the various objectives listed above. It is especially important to keep in mind that cultivation in an orchard does not reduce water loss except by killing weeds which use water in the same manner as the prune trees. Unnecessary stirring of the soil, especially when it is wet, will not only increase the cost of operating the orchard but may cause definite injury to the soil by compacting it and causing plow sole to form.

This entire subject is covered in more detail in Ext. Cir. 50, *Essentials of Irrigation and Cultivation of Orchards*, by F. G. Veihmeyer and A. H. Hendrickson.

3. Covercrops

Some of the reasons advanced for the use of covercrops are as follows: to reduce soil erosion, increase water penetration, fix nitrogen (leguminous covercrops only), and improve the general physical condition of the soil. It should be pointed out that covercrops will not do all the things listed above under all conditions. For example, leguminous covercrops with proper inoculation of nitrogen-fixing bacteria have given increases of total nitrogen in the soil in cool, humid sections, but have not done so under the hot, semiarid conditions found at Davis.

The leguminous covercrops most widely grown in prune orchards are *Melilotus indica*, the vetches, and bur clover. Horse beans, fenugreek, lupine, and field peas have been successful in more limited areas. Mustard, rye, oats, and barley are the most widely used nonleguminous covercrops. Volunteer covercrops consist of various mixtures of nonleguminous and leguminous plants.

Covercrops that are planted by the grower are nearly always seeded in the fall, and cultivated under in the spring. They should not be allowed to grow too late in the spring because they will compete with the trees for nitrogen and water. Furthermore, a covercrop that is allowed to mature will not decompose satisfactorily in the soil.

Usually covercrops may be planted for one or more of the reasons given above without danger of damaging the trees. However, it may not be advisable to plant covercrops in nonirrigated orchards in regions of low rainfall. If they are planted they should be turned under earlier than usual.

4. Irrigation

An increasing number of prune orchards have been brought under irrigation during recent years. There are, however, rather large areas in the coastal counties north of San Francisco Bay where the rainfall and humidity are high enough to make it possible to grow prunes without irrigation. Even in these districts, some growers have improved the health of their trees by irrigating.

No exact rules can be given concerning the number of irrigations desirable, since the amount of water needed depends on climatic conditions, size of the trees, distance between trees, type of soil, amount of rainfall, time of working under the covercrop, and number of weeds allowed to grow between irrigations.

The number of irrigations given the trees before the fruit is harvested usually varies from one to 4. Another irrigation, as soon after harvest as possible, is also recommended. If for any reason it is not possible to irrigate more than once during the season, it will be best to apply the water before harvest.

To be effective over a reasonable period of time, an irrigation should wet the soil to a depth of at least 5 or 6 feet. In order to be certain that this is being accomplished, it is suggested that the soil be examined by means of a soil auger or tube.

It is important that the trees have an adequate supply of readily available moisture at all times. However, there is usually no need to wet the soil deeper than the root zone. Excess water that drains down below the root zone will not only be wasted but in some cases will raise the water table with resulting injury to the trees.

There is one exception to this general rule that is not often encountered in prune orchards but should be kept in mind. It is sometimes possible to leach out excessive concentrations of certain salts, including chlorides, sulfates, and boron compounds, by adding more water than the trees themselves require.

Sometimes the orchard is cultivated between irrigations but in other cases the original furrows or levees are left for several irrigations. If the orchard is not cultivated between irrigations there will usually be enough weed growth present to use up a considerable amount of water; so the decision as to whether or not to cultivate at this time should usually be based on the relative cost of cultivation and the cost of water used by the weeds.

5. Fertilization

Prune trees that are not making normal growth and have pale green leaves will usually respond to applications of nitrogen fertilizers. Potassium applications may also be needed in certain instances (see below). For a more complete discussion of fertilizers, see Exp. Sta. Cir. 354, *Fertilizers and Covercrops for California Deciduous Orchards,* by E. L. Proebsting.

Nitrogen deficiency is usually indicated by poor growth, and by pale green leaves. However, not all prune orchards will give a profitable response to applications of nitrogen, so it is suggested that where symptoms of nitrogen deficiency are not definite, only one or two rows of trees be treated. If the treated

trees do not respond, there will be no need to add nitrogen to the others.

How much to apply. When needed, the normal application for mature prune trees is from 60 to 100 pounds of actual nitrogen per acre. How much of any given commercial fertilizer this amounts to depends on the percentage of nitrogen in the product—usually indicated on the package, and varying from 15.5 to 82 per cent.

Some of the common nitrogenous fertilizers are ammonium sulfate, ammonium nitrate, sodium nitrate, calcium nitrate, anhydrous ammonia, and urea.

When and how to apply. All of the above materials except anhydrous ammonia should be broadcast on the soil; anhydrous ammonia may be applied in the irrigation water or drilled into the soil.

The ammonium ion, irrespective of whether it comes from ammonium sulfate, anhydrous ammonia, or other compounds, is fixed in the surface layers in most California soils. Nitrifying bacteria must convert the ammonia to nitrate before it can be leached into the root zone. At least a month should be allowed for a substantial part of the ammonia added to be converted to nitrate. All the nitrogen in the nitrate fertilizers, such as sodium nitrate, and half the nitrogen in ammonium nitrate, is immediately available. This simply means that ammonia compounds should be applied earlier in the winter than nitrate compounds. When the fertilizer program is being started, January is a good time to apply ammonia compounds and February a good time to apply nitrate compounds.

After a tree has had its nitrogen reserves built up by an adequate program, the time of application is not especially important, if loss by leaching is avoided.

Animal manure may also be used as a source of nitrogen when obtainable in large enough quantities, and at a price comparable to the inorganic fertilizers.

Potassium deficiency on prunes has been mostly limited to the upper Sacramento Valley, and to localized areas in the coastal valleys. Fortunately the majority of the prune orchards in the state do not require fertilizers containing potassium.

Symptoms. The trouble is associated with leaf scorch, dieback of the branches (see photo), and shriveling of the fruit. The greatest injury occurs when the trees have heavy crops. Trees on peach rootstock will usually be more severely injured than those on myrobalan.

The treatment of the trees in the Sacramento Valley is complicated by heavy cropping and by the fact that the soils have a strong tendency to hold potassium in the surface layers. A potassium fertilizer, such as potassium sulfate, can usually be absorbed by the trees if it is drilled into the soil to a depth of 6 or more inches. Dieback is often not eliminated, however, unless the crop is also reduced. A rather severe pruning is the method usually used to reduce the crop but some dieback may still occur unless the pruning is followed by fruit thinning in years of heavy sets.

Dieback of French prune. This trouble is associated with a deficiency of potassium in the soil.

In the affected foothill areas of Santa Clara Valley the soils have a lower fixing power for potassium than those in the Sacramento Valley, so the fertilizer may be applied to the surface of the soil. The fact that overbearing does not regularly occur in this area is another factor favoring response to potassium fertilizers.

In general potassium deficiency is difficult to correct in prune orchards and soils low in potassium should be avoided.

Phosphorus. Prune trees in California have not responded to phosphate fertilizers even when growing in soils where certain field and vegetable crops show a marked response to phosphate fertilization.

Covercrops have, in some cases, responded to a phosphate fertilizer such as superphosphate. Fortunately, however, most prune orchards are growing in soils that will produce a good covercrop without the addition of phosphate fertilizers.

6. Bracing

Wooden props are commonly used to prevent heavily loaded branches from breaking. Considerable care should be taken to place the props where they are most needed, since it is not economical to support all branches.

Some prune orchards have been braced by running wires from a ring in the center of the tree to the various main branches. Staples or stirrups are used to attach the wires to the branches. If stirrups are used, they must be large enough so that the branches will not be girdled.

The last irrigation before harvest and the cultivation following this irrigation often delay the placing of wooden props until after some breakage has occurred. This trouble is not encountered when wire bracing is used since the wires remain in place and are up out of the way. However, the initial cost of wiring the trees is rather high, and the wires interfere to a certain extent with pruning. So only a few prune growers use this system of bracing. Furthermore, wires are not satisfactory in those orchards where the prunes are harvested with the aid of mechanical shakers.

7. Fruit thinning

Fruit thinning of French prunes is rarely an economical practice. However, it is sometimes justified in years when crops are excessive, especially in areas where the trees are inclined to develop dieback. In some cases French prunes have been thinned by the use of pruning shears. Rather substantial amounts of fruit can be removed in this way, with relatively few cuts.

The Sugar prune, which has a rather brittle wood, is often fruit-thinned during years of heavy sets. Some growers also make a practice of thinning Burton and Imperial prunes.

Spraying the blossoms with certain chemicals is another way to reduce the crop and increase the size of the fruit. This treatment has been satisfactory in a number of orchards, but it will require several more years of experimental work before it will be known how generally it can be practiced. However, the results that have been obtained indicate that

A typical coastal valley French prune tree with wooden props in place to prevent breakage from overloading at harvest time.

chemical thinning will find its greatest application in the upper Sacramento Valley where heavy crops are common. It is not recommended for weak trees and in areas where the fruit sets are usually light.

8. Top-working

Mature prune trees have occasionally been top-worked to introduce pollinizers into an orchard which consisted of a solid block of one of the self-sterile varieties. In some areas especially suited to prune growing, peach, almond, and apricot trees have sometimes been top-worked to prunes. Not all varieties, however, do well on these stocks. Growers have also changed from one variety of prune to another, when the original variety proved unsatisfactory. Cleft, bark, and saw-kerf grafting are the methods usually used for this work. Top-working should not be attempted on very old trees, or on trees that are not in good condition.

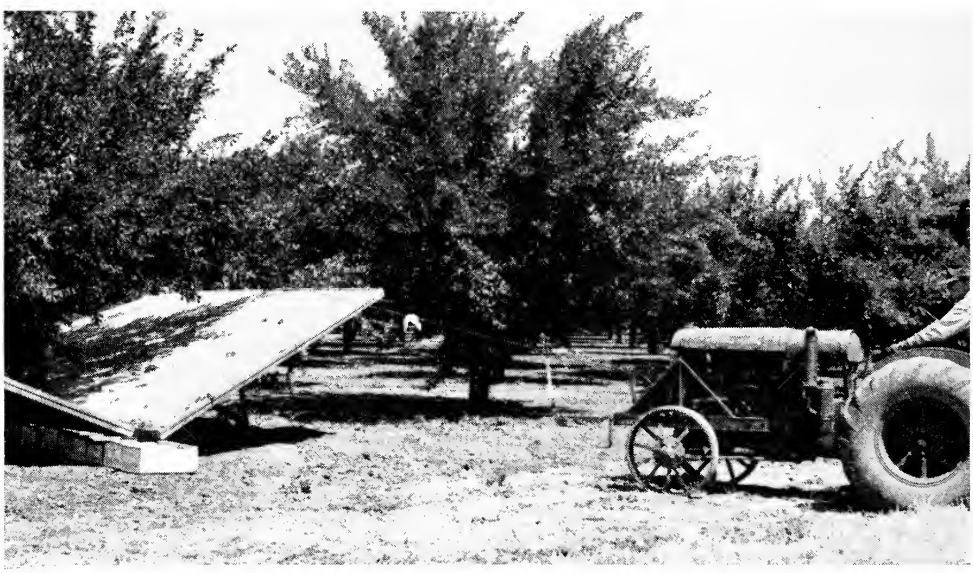
Nursery-budded trees are sometimes difficult to get started when used as replants in old orchards, so some growers have been planting some of the vigorous types of myrobalan and Marianna plum rootstocks and then budding or grafting them when they are several years old. Trees handled in this way require a considerable amount of attention, but it is recommended that the method be given a trial in those cases where nursery-budded trees do not grow satisfactorily.

Top-working is covered in more detail in Ext. Cir. 96, *Propagation of Fruit Plants*, by C. J. Hansen and E. R. Eggers.

9. Harvesting

In contrast with many other fruits, prunes are generally not hand-picked from the trees, but are allowed to drop to the ground, or are shaken to the ground, or onto canvas-covered frames. The methods used for harvesting prunes in the coastal valleys vary considerably from those used in the interior valleys.

In the coastal valleys the prunes usually drop easily to the ground when they are mature, so only light shakings are required. Heavy shaking in these districts will cause immature prunes (often with the fruit stems attached) to drop to the ground. Fruit of this sort is low in sugar and has a high drying ratio. The number of pickings varies from two to



This is the type of mechanical shaker, mounted on a tractor, used to remove prunes from the trees grown in orchards in the interior valleys.

four, but usually less than three results in a mixture of overripe and underripe fruits.

The shaking is usually done with wooden poles equipped with metal hooks. Pieces of rubber hose are often placed over the hooks in an effort to reduce the amount of injury to the bark of the branches. The prunes are generally picked up from the ground by hand and placed in picking pails. The full pails are emptied into lug boxes which have been conveniently distributed along orchard roadways.

In the interior valleys, prunes tend to hang on the trees even after they have become fully ripe, so it is necessary to harvest the fruit in a manner different from that described above for the coastal valleys. Growers rarely make more than two pickings in the interior valleys and the crop is often shaken off in one picking. Shaking part of the prunes from the trees with the object of separating the mature fruits from the immature ones has usually not given the desired results in the interior valleys. In most cases a considerable number of underripe fruits will be shaken off, while some overripe fruits will remain on the trees. When the crop is harvested in only one or two pickings, there will, of course, be some overripe and some underripe fruits. This difficulty, however, is not as serious as might be expected because the ripening period is shorter in the interior valleys than in the coastal valleys.

Poles with or without hooks are commonly used to shake and knock the prunes off the trees. In recent years, tractor-driven mechanical shakers have been extensively used in interior valley prune orchards. The cable, which transmits the shaking action from the tractor to the tree, is attached to one large branch at a time. Very little breakage occurs if the trees are in good condition and the tractor driver is careful, but there are some orchards so heavily infected with wood rot that the use of mechanical shakers would result in excessive damage to the trees.

Mechanical shakers may be used to shake prunes to the ground but they are best used in conjunction with catching frames. These frames, which are made of wood covered with wire netting and light canvas, are placed at convenient angles so that when the fruit is shaken it will roll directly into boxes which are placed on the ground in line with the tree trunk (see photo). Prunes harvested in this manner will be free of dirt and stones but all leaves and twigs that fall will go into the boxes. A good way to remove the leaves and twigs is to blow them out by passing the prunes through a strong draft of air.

Mechanical shakers, and catching frames are being used by a considerable number of growers, especially in the Sacramento Valley, and it is likely that more will be used in the future. However, it is probable that they will not be found desirable in most of the prune orchards of the coastal valleys, because the prunes in these areas ripen over a long period and drop to the ground when ripe.

Some prunes are grown in areas where the climate is intermediate between that found in the typical coastal and typical interior valleys. In these areas, the crop will tend to hang on the trees when ripe but not as tenaciously as in the interior valleys. Harvesting practices in such areas will have to be adjusted to fit the conditions and will therefore be intermediate between those described above.

Coöperative Extension work in Agriculture and Home Economics, College of Agriculture, University of California, and United States Department of Agriculture coöperating.
Distributed in furtherance of the Acts of Congress of May 8, and June 30, 1914.
J. Earl Coke, Director, California Agricultural Extension Service.

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Prune Production
in California

Carl J. Hansen

CALIFORNIA AGRICULTURAL
EXTENSION SERVICE

CIRCULAR 180

Section III. Diseases

Prune trees are subject to a number of diseases that may affect both yield and quality of fruit

By E. E. Wilson

Certain of the diseases described in this section, as well as many insect pests, will be kept under control by a general spray program. Since new methods of control and new chemicals are being discovered rapidly, the grower is advised to consult his local Farm Advisor for a copy of the latest recommended spray schedule.

The following information is, therefore, a general description of the diseases to which prune trees are subject, and includes recommendations for controlling specific troubles.

1. Parasitic diseases

Brown rot may be caused by either of two related species of fungi: *Sclerotinia laxa,* which is particularly destructive to blossoms and twigs and sometimes rots fruit; and *S. fructicola,* which is much less destructive to blossoms than *S. laxa,* but more destructive to fruit.

The Burton variety is notably susceptible to blossom infection by *S. laxa;* the disease sometimes becomes established in this variety and then spreads to others.

IN THIS SECTION

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In some cases brown rot blossom blight may appear first in prune trees adjacent to an almond or apricot orchard.

What to look for. The first symptoms of brown rot (from either fungus) appear at or shortly after blossoming time, as a browning and withering of the flowers (see photo). If *S. laxa* is involved the disease extends into the spurs and twigs within a week or so. *S. fructicola* seldom attacks large numbers of blossoms under California conditions, and usually invades only the blossom, or infrequently the spur tissues. Consequently it does not seriously affect the crop at this early stage.

Green prune fruits apparently are resistant to infection and evidence of brown rot between the blossoming and the time the fruits mature is rarely seen. When the fruit begins to ripen, however, the disease becomes active and develops as a rather firm, brown spot in the flesh. Because of the dark color of the prune skin, the disease is difficult to locate and may not be conspicuous until the fruit is entirely rotted and the fungus appears on the surface (see photo).

The disease affects not only the fruit on the trees, but may develop in harvested fruit that is held a few days before drying.

Contrary to some beliefs, there is evidence that the fungus is unable to grow in the flesh of dried fruit, and is there-

Photos showing the effects of infection of brown rot fungus. Left, withering of leaves and twigs; right, rotting of the fruit.

fore unable to spread through bins of dried prunes.

Control. For preventing blossom infection by *S. laxa* the trees should be sprayed with a 10-10-100 bordeaux mixture* at the time the unopened flowers emerge from between the scales of the winter buds.

Typical pattern on the bark of a prune tree, caused by diamond canker.

To prevent fruit rotting, wettable sulfur spray or sulfur dust should be applied before harvest. Though sprays are probably more effective than dusts, they are slower to apply and require heavier equipment. But whether dusts or sprays are used, it is important to start treatment well before the disease begins to appear—the first treatment 3 to 4 weeks before harvest; repeat at 10-day intervals, applying a total of 3 dustings or 2 sprays.

Bacterial canker (bacterial gummosis) is caused by a parasitic bacterium, *Pseudomonas syringae.*

What to look for. In prunes this disease is usually present as elongated, sunken cankers on the limbs and trunks. These may extend rapidly through the bark and girdle the branch, causing it to die. Death of branches or entire trees is most common in the spring or early summer—the disease is not active later in the summer.

The Sugar variety is probably the most susceptible to bacterial canker; the Standard, Stuart, and French varieties somewhat less so. It is also felt that prunes on myrobalan rootstock are more severely affected than those on peach root.

* A 10-10-100 bordeaux mixture contains 10 pounds of copper sulfate and 10 pounds of hydrated lime or quicklime, in 100 gallons of water.

No control program has been developed so far that is entirely satisfactory. However, infection may be reduced by spraying the trees with 16-16-100 bordeaux mixture early in the winter, after the leaves are off. This spraying should be accompanied by a removal of diseased branches, where feasible.

Diamond canker is caused by a virus and attacks French prunes almost exclusively. It occurs most commonly in the areas north and south of San Francisco Bay; is not found in the San Joaquin Valley, and only occasionally in the Sacramento Valley.

What to look for. The symptoms of this disease are the roughly diamond-shaped cankers produced by thickened, corky tissue forming in the bark of branches, and breaking through to the surface (see photo). These outgrowths tend to form at the bases of lateral branches, at pruning wounds, and at the margin of areas killed by the bacterial canker organism.

Rough areas where the outer bark becomes cracked and loosened are sometimes found on the youngest twigs of affected trees and these areas develop into typical diamond cankers as the twigs grow older.

Trees seldom die from the effects of diamond canker, but they remain stunted and gradually succumb to wood rots and insect borers. In the early stages, diseased trees often produce greater quantities of large-sized fruit than trees that are not affected.

What to do. No satisfactory control program has been found, since the disease is caused by a virus and is transmitted to any new scion that might be top-worked to the old rootstock. Chemical sprays and injections also fail against diamond canker.

Replacement of affected trees with a resistant variety (anything except French prune) is the most practical means of avoiding or combating the disease.

The rust disease of prunes affects the leaves particularly, and is most prevalent in the coastal areas. It is caused by the fungus *Tranzschelia punctata.*

What to look for. In the fall the undersides of the leaves become covered with dark brown to black spore pustules. Usually the attack comes so late that, though heavy leaf fall ensues, little damage is done to the trees.

Control measures are not ordinarily needed.

Oak root fungus disease (Armillaria root rot) is caused by the fungus *Armillaria mellea* which inhabits the soil and invades the trees through the roots. It is common on native oak trees.

What to look for. Affected trees become weak, the leaves turn lighter in color than normal, and eventually die.

The white, feltlike mycelium of the oak-root fungus beneath the bark of a root.

The crown and roots of such trees are discolored and a white, felty growth of fungus is present between the wood and the bark (see photo). Less apparent are cordlike, brown strands of fungus growth along the surface of the roots.

The disease commonly appears in one or more trees in certain areas of the orchard. These areas gradually enlarge as the fungus grows outward along the roots and comes in contact with the roots of adjacent trees.

What to do. The disease is difficult to control, but good results are sometimes obtained by disinfecting the soil.

Remove all of the trees in the affected area, including all of the roots in the top 12 inches of soil. Punch holes from 6 to

Photo showing the typical growth on the roots of a young tree, caused by crown gall.

8 inches deep (8 to 10 inches deep in sandy soil) in staggered rows so that the holes are about 18 inches apart. Into each hole pour 2 ounces by weight (1⅗ ounces liquid measure) of carbon bisulfide. Immediately after pouring in the liquid, plug the holes with soil. After all holes are plugged, apply enough water to the entire area to wet the top 4 inches.

Do not apply the carbon bisulfide nearer than 6 feet from the base of any healthy trees.

Hand- or power-operated equipment for applying this material can be purchased or rented from the manufacturers of carbon bisulfide.

Resistant rootstocks are being tried, but at this writing the experiments are not completed.

Crown gall is the name given to rough growths that develop on the roots and crowns of prune trees as a result of the bacterial parasite *Agrobacterium tumefaciens.*

What to look for. It will be necessary to uncover the crown and perhaps some of the roots of affected trees to observe the galls (see photo).

What to do. A representative sample of any trees bought from a nursery should be examined for crown gall. Those showing the disease should not be planted, and if the percentage of affected trees is too great, the entire lot should be rejected.

Choice of a resistant rootstock will help to avoid the disease also. Marianna 2623 and Marianna 2624 and Myrobalan 29 exhibit considerable resistance.

When the trouble is located in an orchard tree, it may be treated as follows: Remove the soil from around the crown and roots to expose the galls; brush the galls and surrounding tissues to remove all dirt. If the galls are under 4 inches in diameter, they may simply be painted with a solution containing 1 part sodium dinitro-ortho-cresylate (Elgetol 20) and 4 parts methanol (wood alcohol). Galls larger than 4 inches in diameter may be wholly or partially removed by chiseling or knocking; the wounded area including remnants of the gall should then be painted with the Elgetol-methanol mixture which has been diluted with 9 parts water. Use the dilute mixture for disinfecting tools.

Do not apply this treatment in very hot weather. It may be necessary to cover the treated area with soil to prevent sunburn or freezing injury.

2. Nonparasitic diseases

Certain deficiencies (or excesses) of soil elements manifest themselves in tree growth. Since such troubles resemble diseases, they are discussed here.

Boron injury is a result of an excess of boron in the soil. It may be introduced by way of the irrigation water, or it may occur naturally in the soil.

What to look for. The tips of the shoots of injured trees die back (see photo) and the bark becomes cracked and corky, especially in the axils of the leaves (just above where the leaf stems, or petioles, join the twigs). Sometimes gum will exude from the injured parts. Corky areas may also be found on the leaf petioles and on the large veins on the underside of the leaves.

If other conditions are normal for growth, the lateral buds on injured shoots will start to grow, but will be killed back later. By the end of the growing season many of the nodes will be considerably enlarged.

These symptoms may be seen throughout young, vigorous trees, but on old trees they are often restricted to the watersprouts. High concentrations of boron will finally weaken the trees so much that little or no fruit is produced.

What to do. The condition may be *avoided* by being certain that irrigation water used does not contain an abnormal amount of boron. In this respect, a water analysis is helpful.

Because of variability in soils, and in the amount of rainfall in different places,

Typical twig and leaf injury that may indicate an excess of boron in the soil.

it is almost impossible to say exactly how much boron in the water will result in injury. However, water containing in excess of about 1.5 parts per million of boron is usually considered dangerous to use on prune trees.

Where the trouble is found to exist, the boron may be leached out of the soil by the use of satisfactory irrigation water in excess of that needed to sustain the trees. This treatment will work well only on soil that is sufficiently porous, and if the drainage is good.

In any event, avoid planting prunes in soil that has an excess of boron.

Experiments with young trees in small containers indicate that less boron injury will occur if the trees are on almond or myrobalan rootstocks, than if they are on peach root. However, care should be taken not to use almond roots in heavy soils that tend to be a little too wet.

Copper deficiency (exanthema) has been found to a limited extent in several counties of California.

What to look for. The tips of the stems of injured trees are killed (see photo) and the lateral buds are forced into growth. These lateral shoots may in turn die back and some of the leaves will fall. In addition, the bark of some small branches may be rough and exhibit a corky appearance.

Imperial prune shoots, showing injury that indicates a deficiency of copper in the soil.

In many respects the injury resembles that caused by excess boron, but copper deficiency does not produce corky areas on the leaf petioles and veins, and usually does not cause injury to the stems just above the buds.

What to do. Prune trees showing symptoms of copper deficiency have been cured by spraying the young leaves with a 10-10-100 bordeaux mixture.

The addition of 1 to 5 pounds of copper sulfate per tree to the soil has sometimes been effective, but where the fixing power of the soil was high, even considerably heavier applications have not been satisfactory. When trying this treatment, the copper sulfate should be spaded in around the base of each tree, or placed in the bottom of a trench. In most cases, this trench should be about 3 feet from the trunk of the tree.

Zinc deficiency (little leaf) has been found to a limited extent in prune orchards.

What to look for. A common symptom is a mottling of the leaves, with yellow streaks and splashes between the veins. Many of the affected leaves are small in size and occur in tufts at the ends of the shoots.

What to do. Test a few trees to determine if the symptoms described are due to a zinc deficiency. To do this, drive small pieces of galvanized (zinc coated) iron into the branches. If this clears up the trouble, commercial control may be obtained by spraying the trees when they are completely dormant with a spray containing 25 to 50 pounds of zinc sulfate in 100 gallons of water.

If the trees have not received a fall irrigation, the spraying should be delayed until after the first heavy rain.

In order that the information in our publications may be more intelligible it is sometimes necessary to use trade names of products or equipment rather than complicated descriptive or chemical identifications. In so doing it is unavoidable in some cases that similar products which are on the market under other trade names may not be cited. No endorsement of named products is intended nor is criticism implied of similar products which are not mentioned.

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Carl J. Hansen

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Section IV. Insect pests

Prunes are attacked by a wide variety of insect pests which must be controlled by sprays

By Leslie M. Smith

Insect pests may be divided into two classifications—those that suck juices from the plants, and those that actually bite off and eat solid particles of the leaves and fruit. The former must be controlled by the use of chemicals that come into contact with their bodies; the latter may be controlled by the use of poison which they eat along with their food.

1. Sucking insects

Mealy plum aphid, *Hyalopterus pruni* (Geoff.), feeds on the lower surfaces of the leaves and causes them to be stunted and somewhat curled. They devitalize the trees, retard the growth of new wood, reduce the sugar content of the fruit, and in many cases cause the prunes to split open on the trees.

What to look for. The aphid as seen on the tree is pale green and covered with a white, mealy wax. They pass the winter in the egg stage. The eggs are found near the bases of the buds and usually between the buds and the twigs (photo, page 2).

IN THIS SECTION

Leslie M. Smith, the contributing author for this section, is Professor of Entomology and Entomologist in the Experiment Station, Davis.

Control measures consist of spraying in mid-winter to kill the overwintering eggs on the trees. Coal tar distillate emulsions are effective, at the rate of 2 gallons of actual coal tar to 100 gallons of water. Various dinitro compounds, such as sodium dinitro-o-cresolate at 12 ounces (dry weight) per 100 gallons of water, also give good results.

Scale insects. Various scale insects occur on prunes, including olive scale, *Parlatoria oleae* (Colvee); San Jose scale, *Quadraspidiotus perniciosus;* brown apricot scale, *Lecanium corni* Bouche; and the Italian pear scale, *Epidiaspis piricola* (Del Guer).

What to look for. Scale insects are minute, gray, disk-shaped insects that settle on the bark and limbs of trees in great numbers. The olive scale, Italian pear scale, and San Jose scale are described as "armored" because they construct a shell and live under it. The brown apricot scale is unarmored, and hence easier to kill with spray.

Control of armored scale consists of spraying with a 5 per cent commercial winter oil emulsion, put on when the trees are fully dormant and after the first heavy rains. Unarmored scale may be controlled with a 4 per cent winter oil emulsion.

Pear thrips, *Taeniothrips inconsequens* (Uzel), are probably the most destructive pests which attack prunes. They

Left, egg of mealy plum aphid in usual position at base of bud; right, French prunes split as a result of mealy plum aphid infestation.

feed on the flower buds and young fruit, causing severe loss of crop.

What to look for. About the latter part of February, strike bud clusters into the palm of the hand, and look for the small, black, adult thrips. These adults emerge from the soil about February 19, and continue to emerge until near the end of March. From the ground, they fly into the trees and crawl into the opening buds, where they feed on the succulent tissue. This causes the buds to "bleed," a symptom commonly noticed in the early morning. Later the larvae, or white thrips, feed under the jacket and scar the fruit.

Control is obtained by dusting with a 5 per cent DDT dust, using 30 pounds per acre, and applying it just after the flowers are in full bloom. This will avoid interference with pollination.

If brown rot or green fruit rot are present, it is advisable to use a DDT-sulfur mixture consisting of 5 per cent DDT and 50 to 80 per cent sulfur.

Red spiders (red spider mites). Four species of red spiders attack prune trees. They are brown mite, *Bryobia praetiosa* Koch; European red mite, *Paratetranychus pilosus* C. & F.; two-spotted mite, *Tetranychus bimaculatus* Harvey; and Pacific mite, *Tetranychus pacificus* McG.

What to look for. The brown mite can be recognized under a magnifying glass by its flat body and by its front legs, which are much longer than its other legs. The European red mite is bright red, with a few long white hairs on its back. Neither of these mites spins much web.

The two-spotted mite and the Pacific mite produce abundant webbing on both sides of the leaves. They also cause minute yellow spots on the leaves which give them a "salt and pepper" appearance. Persistent feeding on the leaves will cause the leaves to turn yellow and drop so that the trees may be completely defoliated by the middle of August.

Control of brown mites and European mites is usually obtained by the midwinter spraying of oil emulsions at 4 per cent. However, any of the mites may be controlled by any of 3 methods as follows: spraying with summer oil emulsion

at 1½ per cent plus a good spreader; dusting with sulfur; dusting with dinitro dusts, following the manufacturer's directions. Sulfur dusting may not work in some localities, so the grower should consult his local Farm Advisor before using sulfur to control spider mites.

Red spiders are less injurious in orchards well supplied with soil moisture.

2. Chewing insects

Leaf-eating caterpillars are just what the name implies—they are the immature stages of moths, which chew up and eat leaves. The following species are occasionally destructive: fall canker-worm, *Alsophila pometaria* (Harris); spring canker-worm, *Palecrita vernata* (Peck); red-humped caterpillar, *Schizura concinna* (A. & S.); tent caterpillars, *Malacosoma* spp.; and leaf rollers, *Archips* spp.

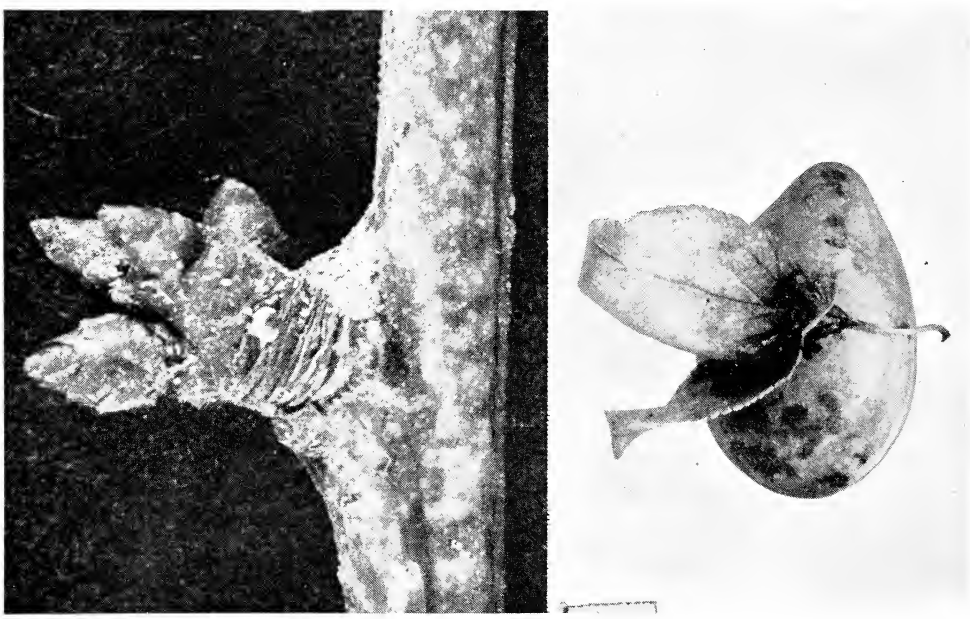
What to look for. Caterpillars of any kind are easily recognized, and if seen in any great numbers in the orchard (in springtime they are most injurious) control methods will probably be needed.

Control is obtained by spraying during early spring with basic lead arsenate—3 pounds of lead arsenate to 100 gallons of water. This preparation leaves a poisonous residue on the fruit as well as on the leaves. So if necessary to spray for leaf-eating caterpillars after the fruit has formed on the trees, use pyrethrum extract, applied according to the manufacturer's directions.

Bud moths, *Spilonota ocellana* (D. & S.), are primarily leaf-feeders, but as the fruit enlarges the larvae tie a leaf to a fruit and feed on the fruit under the protection of the leaf (see photo).

What to look for. Bud moths do not bore far into the fruit, but feed on the surface, producing shallow holes which exude gum. The very young larvae overwinter in the crotches of twigs under a silken covering (see photo).

Control may be obtained by spraying with basic lead arsenate (see above) or DDD. The spray should be applied when the fruit is in the jacket stage, and again in June when the eggs begin to hatch;



Left, hibernaculum of overwintering cocoon of bud moth (about twice natural size); right, bud moth damage on young prune (about actual size).

or the June spray may be used together with a second application after harvest.

Parathion as a spray appears to give excellent results but this material may leave an illegal poisonous residue on the fruit. It is suggested that growers intending to use parathion get in touch with their local Farm Advisor for the latest information on this product.

The orange tortrix, *Argyrotaenia citrana* (Fern.) in the caterpillar stage enters the fruit through a small, round puncture (see photo).

What to look for. The mature larva of the orange tortrix is about 1½ inches long and light tan in color. The photo shows the characteristic damage done to the fruit by this pest.

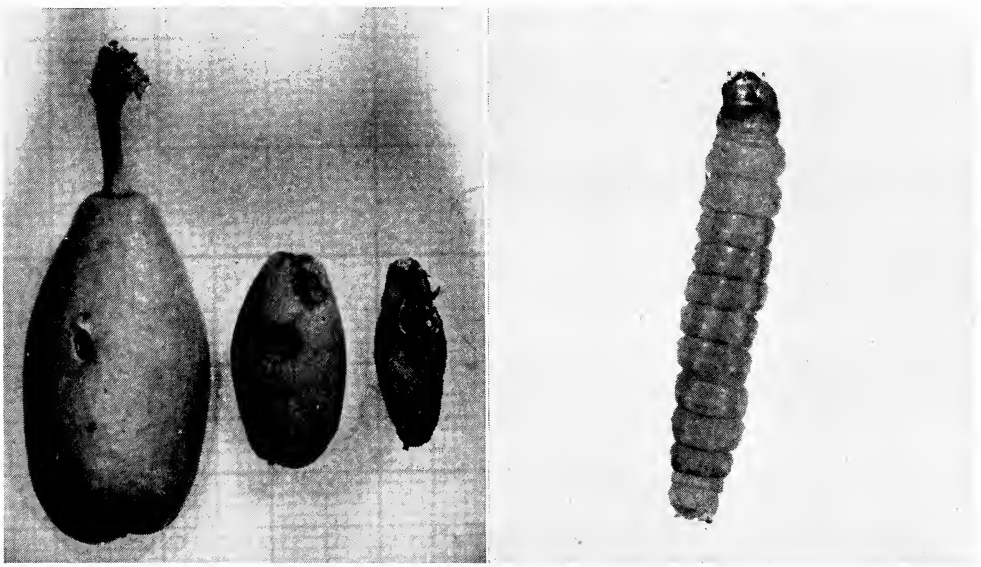
Control may be obtained by dusting with cryolite dusts. Parathion, at 1 pound of 15 per cent wettable powder per 100 gallons of water, appears promising for control, but may leave a poisonous residue on the fruit. Growers should consult the local Farm Advisor before using parathion.

Pacific peach tree borer, *Sanninoidea opalescens* (Hy. Edw.), does serious damage in some districts.

Larva of the Pacific peach tree borer (exposed to view by removing bark of the tree).

What to look for. The Pacific borer is a white caterpillar with a brown head. These pests bore under the bark, generally at the soil level, but may also tunnel into the bases of the main roots. They sometimes girdle and kill the trees.

Their presence is indicated by gum and reddish excrement oozing from the tunnels near the soil level.



Prunes damaged by larvae of the orange tortrix, and (right) the larva itself.

Control. The worms may be dug out, or killed by running a flexible wire probe into the burrows, but such a method is slow and tedious.

A quicker method is to fumigate the soil around the trees with paradichlorobenzene (PDB). Level the soil surface around the tree; sprinkle from ¾ to 1 ounce of PDB around the tree in a circle about 2 inches wide, with the inner margin 2 to 4 inches from the trunk. Cover the material to a depth of 2 to 4 inches, with soil.

For best penetration of vapor (which kills the worms) the soil should be warm and dry, so late summer and fall are the best times to apply PDB.

Caution: Do not use an overdose of PDB, nor permit the material to touch the tree—serious injury may result.

The peach twig borer, *Anarsia lineatella* (Zeller), burrows into and kills buds and twigs and may seriously infest the fruit.

What to look for. The peach twig borer is a reddish-brown caterpillar, about ½ inch long. The larvae, after wintering just beneath the outer bark in the crotches of the branches, emerge in the spring to infest the buds and new shoots. Later they change to tiny moths that fly around the orchard, depositing eggs

Sugar prunes injured by midsummer brood of twig borer larvae.

which give rise to subsequent generations of caterpillars which infest the fruit.

Control is gained by two applications of lead arsenate spray; use 3 or 4 pounds of basic lead arsenate, ¼ to ⅓ pound of spreader, per 100 gallons of water. The first spray should be applied in the early jacket stage of the buds, just after petal fall. Do not spray during bloom or the honeybees will be killed. The second application should be made when the first wilted shoots appear, usually between May 5 and May 20.

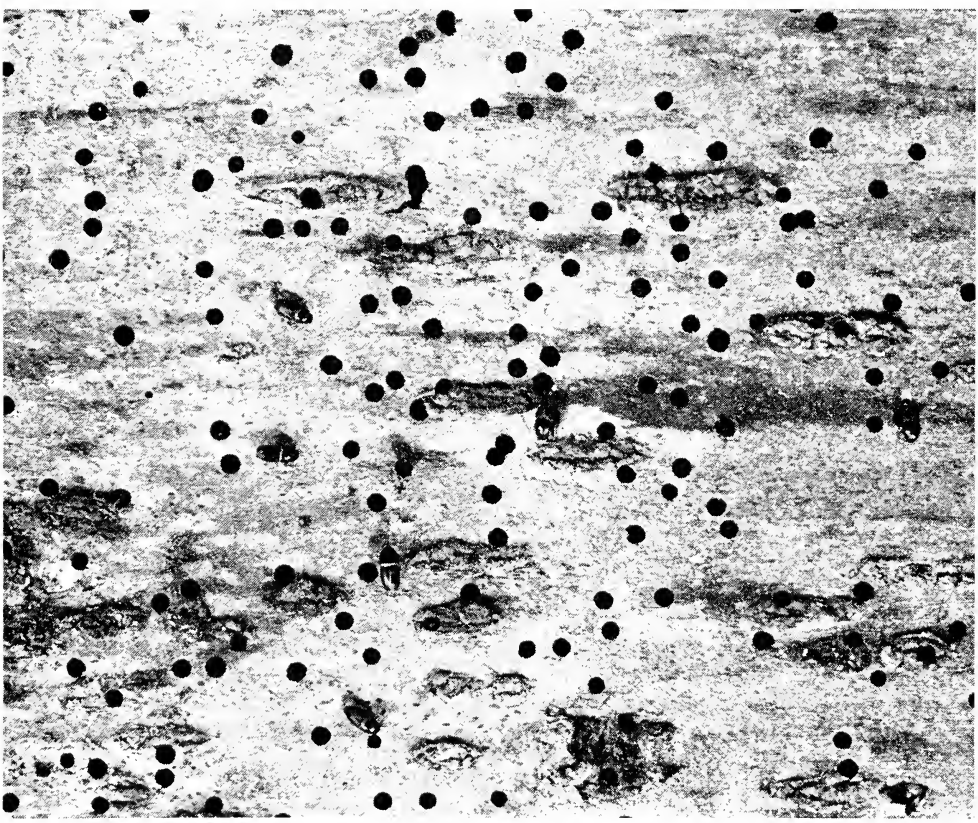
In some districts one lead arsenate spray, applied either in the jacket stage or when the second brood appears in May, gives control. The local Farm Advisor should be consulted on this.

The western flat-headed borer, *Chrysobothris mali* (Lec.), attacks sunburned or otherwise injured areas of trunks and larger limbs, tunneling into the inner bark and sapwood, and sometimes girdling limbs.

NOTE: Where spraying is recommended in controlling diseases or pests, only the formula is given. No attempt has been made to indicate the amount per acre of the material that is needed; these amounts would vary too much with local conditions. In all cases, however, it is assumed that where spraying is recommended, enough material should be applied to wet all parts of all trees thoroughly.

What to look for. The larvae resemble white grubs with flattened bodies greatly enlarged at the front end.

Control consists of pruning to reduce sunburn and keeping the trees healthy



Adult shot-hole borers, showing exit holes in the bark of a French prune tree.

and vigorous. The borers are not so likely to attack healthy wood.

The branch and twig borer, *Polycaon confertus* (Lec.), bores clean, round holes at the bases of the buds and fruit spurs and in the forks of small twigs.

What to look for. This pest is a slender brown beetle, about ¼ inch long. It breeds in dead oaks and in prunings from fruit and other trees.

Control consists of cleaning up and burning all dead brush and prunings around the orchard.

The shot-hole borer, *Scolytus rugulosus* (Ratz.), attacks prune trees in much the same manner as does the western flat-headed borer. Weak parts of the tree are susceptible to damage from the shot-hole borer.

What to look for. This pest is a very small, brown or black beetle, about 3/32 inch long (see photo). The eggs deposited under the bark hatch into white grubs which mine the sapwood and, in severe cases, reduce it to a powder.

Control consists of burning prunings and destroying all dead trees and limbs before spring. Vigorous trees are fairly resistant, so irrigation, fertilization, and cultivation help prevent injury by this beetle.

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